GEOLOGY

Physiographic Region

The Bourbeuse River watershed lies within the Salem Plateau subdivision of the Ozark Plateau. The majority of the Bourbeuse River is contained within the Ozark Border region. The region is composed of steep-sided hills and deep valleys, separated by gently rolling uplands. Soils are typically thin outside of the lowland areas. In these areas, decomposed bedrock has formed an unconsolidated residual material (see glossary). This residuum allows high rates of groundwater discharge (Vandike 1995).

Geology

The geology (see map) of the Bourbeuse River valley is similar to the upper Meramec River watershed. The Bourbeuse River watershed, however, possesses a range of surface rocks varying in age from the younger Pennsylvanian to the older Ordovician Period (Missouri Department of Natural Resource (MDNR) 1984, 1996). By comparison, its rocks are younger than the Meramec River watershed, whose rock formations date to the Pre-Cambrian Age. An interesting feature of the Bourbeuse River watershed is the two north trending faults that "sandwich" the newer Pennsylvanian Age formations between the older Ordovician Age formations. The western fault runs parallel to Highway 19, but lies 3-4 miles to its west. The eastern fault runs parallel to I-44 before turning north along Highway 185, intersecting Spring Bluff township, and finally, ending east of Beaufort. The interior of the sandwich contains, from greater to lesser extent, the Pennsylvanian undifferentiated, the Roubidoux Formation, and a collection of Ordovician Formation rock types containing Smithville, Potter and Cotter, Jefferson City Dolomite formations. On either side of the interior are the Roubidoux Formation and Gasconade Dolomite. Stream gradient is not affected by the presence of the fault. Possibly, the fault contributes, along with the Roubidoux Formation and Gasconade Dolomite rock type, to the formation of springs. The largest spring, Kratz Spring, emerges from the Gasconade Formation. Few other springs exist because of the presence of Pennsylvanian age rock and Jefferson City Dolomite that prevent water movement to subsurface levels.

Blue Springs near Bourbon, Missouri has a measured flow of about 4.9 to 7.05 cubic feet per second (CFS). The flow of the spring exceeds that which the surface runoff from the Blue Springs Creek drainage area in the Meramec River watershed can produce; therefore, an independent watershed consultant hypothesized that the spring is receiving groundwater from another watershed (Tryon 1996). Tryon (1996) analyzed static-water well levels, sinks, faults, valley lineaments, and leaky ponds to conclude that a portion of the Boone Creek watershed of the Bourbeuse River watershed is supplying water to Blue Springs.

Losing Streams

A losing stream is defined as a stream that loses 30 percent or more of its flow into an aquifer within two miles of flow discharge (MDNR 1994; Clean Water Commission Water Quality Standards 10 CSR 20-7.01). Permeable rock type is responsible for the movement of water to subsurface levels. Almost all of the watershed has poorly sustained base flows except Spring Creek below Kratz Spring and Bourbeuse River below Spring Creek.

Knowledge of groundwater sources such as losing streams are important to safeguard water supplies. On some stream systems the MDNR’s Division of Geology and Land Survey has conducted dye tracing to

Table 1. Soil characteristics of the generalized soil associations (SCS 1979) related to hydrology, water management, erosion, and runoff within the Bourbeuse River watershed (SCS Gasconade County Soil Survey 1994, SCS Franklin County Soil Survey 1989)

	Feature Affects		Water Erosion Factors[2]		Water Features	
Soil Name	Grassed Waterway[1]	Drainage	K[2]	T	Hydro-Soil Group[3]	Water Capacity[4]
Hartville	Erodes easily, percs slowly	Percs slowly, frost action	0.28-0.43	4	C	0.1-0.24
Union	Erodes easily, shallow root zone	Percs slowly, slope	0.43-0.43	4	C	0.11-0.21
Goss	Large stones, slope, droughty	Deep to water	0.10-0.24	2	B	0.04-0.17
Peridge	Erodes easily	Deep to water	0.37-0.32	5	B	0.16-0.20
Ashton	Erodes easily	Deep to water	0.43-0.28	4	B[a]	NA
Cedargap	Large stones	Deep to water	0.10-.024	5	B[b]	0.04-0.18
Nolin	Erodes easily	Deep to water	0.43-0.43	5	B[c]	0.18-0.23
Hobson	Erodes easily, droughty	Percs slowly, slope	0.37-0.37	3	C	0.01-0.24
Clarksville	Large stones, slope, droughty	Deep to water	0.28-0.28	2	B	0.05-0.12
Gasconade	Large stones, slope, droughty	Deep to water	0.20-0.20	2	D	0.05-0.12
Coulstone	Droughty, slope	Deep to water	0.24-0.24	3	B	0.06-0.09
Pope	Erodes easily	Deep to water	0.28	5	B	0.10-0.18
Beemont	Slope, perks slowly	Deep to water	0.32-0.24	3	C	0.14-0.12

Table 2. Drainage area of hydrologic units, Bourbeuse River watershed, Missouri (Watersheds in Missouri, USDA and SCS, 1990). The hydrologic unit code - 07140103 - is the prefix to the 11-digit and 14-digit (USDA, SCS) code.

USDACode	Major Stream	Max Order	Area (acres)	Area(sq.mi)	% of Basin
020-002	Lanes Fork	4[1]	30,846	48.12	5.71
020-001,003	Upper Bourbeuse River	5	53,736	83.83	9.95
040-001,002	Dry Fork	4	74,934	116.90	13.87
090-002	Brush Creek	5	48,197	75.19	8.92
090-003	Little Bourbeuse River	4	38,004	59.29	7.03
090-001,004,008	Middle Bourbeuse River	6	113,397	176.90	20.99
090-005	Red Oak Creek	4	41,270	64.38	7.64
090-006	Boone Creek	4	32,721	51.04	6.06
090-007	Spring Creek	4	34,227	53.39	6.33
100-001,002	Lower Bourbeuse River	6	72,986	113.86	13.51
	Total Bourbeuse River basin		540,318	842.90	100.00

[1]Little Bourbeuse Creek

determine a stream's potential to lose to lower aquifers. Recent dye tracing around the Sullivan sewage treatment plant has led to the reclassification of Winsel Creek as a losing stream (Sullivan Independent News, November 15, 1995). Dry Fork has losing sections extending from its headwaters to nearly the confluence with Brush Creek. Two oil-product pipelines, the Continental and Explorer, cross the Dry Fork. Dry Creek in the Lower Bourbeuse River watershed is another losing stream. Finally, an unnamed tributary to Boone Creek is also classified as a losing stream.

Soil Associations

Within the Bourbeuse River watershed, two soil surveys, the Soil Survey of Franklin County (SCS 1989) and the Soil Resources Inventory of Gasconade County (SCS 1994), are completed and published for use. Osage, Maries, and Phelps counties have surveys completed but not yet available to the public. Crawford County is presently being surveyed by soil scientists. With some exceptions, the generalized state soil associations found on the general soil map, produced in 1979, combine major soils into associations that adequately describe soils in the Bourbeuse River watershed. The Union-Goss-Gasconade-Peridge and the Hobson-Clarksville-Gasconade general soil associations are contained within the Ozark Border land resource area, and within the Ozarks land resource area, the Hobson-Coulstone-Clarksville, and the Hartville-Ashton-Cedargap-Nolin soil associations. The Hartville-Ashton-Cedargap-Nolin soil association parallels the river and is composed of alluvium. This generalized association adequately describes river bottom soil associations with some exceptions. For example, the Franklin County survey, a more precise survey, describes this area paralleling the river as the Haymond-Pope association; however, the Gasconade County survey in the western portion of the watershed lists the Nolin-Cedargap association as the floodplain soil type. Nolin is also found in the floodplains of other Bourbeuse River tributaries such as the Dry Fork. On SCS aerial photographs, the Nolin, Pope, and Cedargap soil types are often found in river bottoms with Clarksville, Union, Beemont soil types on ridges or near slopes. Many of the other major soil types are found on ridges and side slopes of the river valley. Peridge, mentioned on the 1979 generalized soil association map, was not found in either soil survey.

Soil Types

The Ozark Border region is a transitional area between the Central Mississippi Valley Wooded Slopes area and the Ozark region. Ridge-tops have a thin mantle of loess caps and subsoils formed in fragipans (Allgood, F. P. and I. D. Persinger 1979). Fragipans are loamy, brittle subsurface horizons, low in porosity and organic matter and low or moderate in clay. This layer appears cemented and restricts roots. Within the Ozark Border region, soil types are dissimilar to the Ozark region, having Union, Gasconade, Goss, and Peridge (Table 1). Union, Hobson, Goss, and Peridge are found on uplands. Union is a silty loam with clay increasing in its sublayers, thus it tends to allow only slow percolation of water. This soil has a relatively high water erosion factor and runoff potential. Hobson is a more brittle loam that has firm clay loam subsurface layers. Both the Union and the Hobson have fragipans in their subsoil at approximately 60 inches. Goss is similar to Hobson, except it has chert in its surface layers and its subsurface layers; in places the subsurface layers reach bedrock. Goss is low in water erosion potential and moderate in runoff potential. Peridge has a silt loam surface soil overlying a moderately permeable silt loam subsoil. As mentioned, the Haymond-Pope association is found quite extensively along the river bottom and is a generally sandy loam.

Within the Ozark region soil types are variable, generally having infertile, stony clay soils in some areas

and fertile, loess-capped soils in others (MDNR 1986). Stony cherty soils characterize much of the Ozarks. Clarksville is excessively drained and formed in cherty dolomite and limestone residuum. On the surface the soil is a very cherty silt loam underlain by very cherty, silty clay loam (Allgood, F. P. and I. D. Persinger 1979). Lastly, Coulstone is a deep, somewhat excessively drained soil formed in sandstone and cherty dolomite on side slopes of ridges.

Four soil types are found in the river bottom areas along the Bourbeuse River: Nolin, Hartville, Cedargap, and Ashton. Nolin is a brittle silt loam from its surface layers to its subsurface layers. Hartville series, formed in alluvium, consists of very deep, slightly poorly drained, slowly permeable soils on stream terraces. Cedargap series, formed in cherty alluvium, consists of very deep, well drained soils on small floodplains along streams. Finally, Ashton is a deep, well drained soil formed in silty alluvium on low stream terraces.

Erosion Potential

In a 1977 National Erosion Inventory estimate, the Soil Conservation Service showed that the soil erosion from cropland in the form of sheet and rill erosion amounted to five tons/acre/year in the Bourbeuse River watershed. Sheet and rill erosion, involving the removal of thin layers of soil from an area by water and creating channels about 30 centimeters in depth, did not exceed allowable limits of 2-5 tons/acre/year on pasture land; however, sheet and rill erosion did reach 18-24 tons/acre on tilled land (Anderson et al. 1980). Twenty tons per year is equivalent to one-eighth inch of soil. For comparison, in forest soils, with many roots to maintain soil integrity, losses in the Bourbeuse River watershed were less than 0.25 tons/acre/year. Gully erosion problems, extreme soil losses causing trenches that exceed 30 centimeters in depth, were rare in the Bourbeuse River watershed.

Major sources of stream sediment are sheet and rill, gully, streambank, and urban erosion. Remarkably, in the Bourbeuse River watershed, these types of erosion comprised 90%, 5%, 3%, and 1% of the sediment in streams, respectively (Anderson et al. 1980). Compared to other watersheds listed by Anderson, 90% sheet and rill erosion was a high percentage. On the other hand, gully erosion, a more severe type of erosion, was low in comparison to other watersheds. In general, lower gully erosion was a characteristic of Ozark streams.

Stream order was determined using a system of classification that was first defined by Horton (1945) and later modified by A.N. Strahler (1952). Strahler called all unbranched tributaries first-order streams; two first-order streams joined to make a second-order stream, and so on downstream to the stream mouth. MDC East Central Region fishery personnel determined stream mileage and stream order from USGS 1:24,000 topographic maps for all third-order and greater streams. This information was used to make gradient plots of the higher order streams. The three longest streams, greater than twenty miles in total length, are the Little Bourbeuse River, Brush Creek, and Dry Fork.

The drainage area of hydrologic units in the Bourbeuse River watershed (8-digit) were derived from USGS Hydrologic Units, which identify a hierarchy of land for Soil Conservation Service planning (USDA and SCS 1990). The NRCS has digitized 14-digit and 11-digit boundaries. Within the four 11-digit boundaries, we combined several 14-digit hydrologic unit boundaries to calculate acreage and square mileage (Table 2). The total watershed area is 540,318 acres and 842.9 square miles. Lanes Fork, at 5.71% of the 8-digit watershed area, has the smallest percentage area of the watershed, and has the smallest fourth-order stream hydrologic unit. Dry Fork, at 13.8% of the 8-digit watershed area, has the largest fourth-order stream hydrologic unit.

Gradient Plot

MDC East Central Region fisheries personnel collected elevation and distance data (stream miles) from USGS 7.5 minute topographic maps (usually 20-foot contours). Within each hydrologic unit we constructed gradient plots for all fourth-order or greater streams, and for third-order streams that were at least 2.0 river miles or greater (Appendix A; Figures 1 - 62). Those stream systems with high gradients are Coppedge Creek, Clear Creek, and Lanes Fork, and those with low gradients are Pleasant Valley Creek, Three Mile Creek, and Prairie Creek. Lanes Fork, Dry Fork, Lower Peavine and Upper Peavine creeks have a relatively steady decline in slope from their headwaters to their mouth, but Brush Creek, Little Bourbeuse Creek, Little Bourbeuse River, and Upper Bourbeuse River have a high initial slope and a subsequent more gentle slope.

Channel Gradient from Regional Geology

Following the Bourbeuse River along its 147 miles, the river intersects two faults and two different rock types. Within the headwaters of the river, which start near Rolla, MO, elevation starts at 1,140 feet and ends near Union at approximately 500 feet. The major landform in the Bourbeuse River drainage is the Salem Plateau, which tilts north and east. Periodic uplift has elevated older Ordovician rock above younger Pennsylvanian. Gradient and percent slope of tributaries are slightly higher in the lower watershed areas compared to the upper watershed. Composed chiefly of Ordovician rock, the lower watershed has relief intervals that are closer together than in the upper watershed.